Pneumatic Nozzle with Modified Internal Mixing Geometry

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Abstract

Twin-fluid atomizers with internal mixing operation require less energy and provide small drop sizes compared to orifice flow cross-sections. For small drops a good mixing performance of the two phases in front of the orifice is necessary. In commercial nozzles a gas distributor usually disperses the gas into the mutual continuous liquid phase. The newly designed nozzle** is based on the distribution of the liquid into the gas flow by capillaries. The liquid forms jets at the end of the capillaries and lead to their extension by the coaxial gas stream. A continuous liquid flow at the nozzle diameter is always ensured leading to a continuous spray without pulsation within a wide operational range. Drop size distribution and pulsation frequencies of this nozzle design in comparison to conventional nozzle are presented.

A large number of pneumatic nozzles mainly effervescent nozzles with different design are known. In this new nozzle type the disperse air phase is introduced into a mutual continuous liquid phase through holes inside the mixing chamber. These nozzles show good spray performance for low ALR ($ALR = \dot{m}_{gas}/\dot{m}_{liquid}$) [1, 2] compared to external mixing nozzles. For high and very low ALR however, the spray tends to become unstable or pulsating [3, 4] and the assumption of a continuous liquid phase may be questioned. The flow regime inside the nozzle obviously becomes unstable, i.e. the void fraction of liquid and gas within the orifice fluctuates.

Liquid is sprayed by compressed air with a new twin-fluid atomizer as shown in Figure 1. The gas enters through the two side ports into the mixing chamber. The liquid is introduced through seven capillaries with diameters of 0.5 mm in contrary to [5] with only one capillary. At the end of the capillaries jets are formed, which are elongated by the pressure field up to the orifices with diameters in a range of 1 to 2 mm. Due to the flow pattern, the mean liquid flow rate is widely constant over the cross-section. An unstable or pulsating spray is avoided reducing the span of the sprays. The spray data are compared to those obtained with a conventional nozzle with equal orifice diameters and comparable flow rates. The measurement program includes the drop size distribution and the pulsation frequencies observed at unstable process conditions. For the liquids a viscosity range of 1 to 300 mPas is considered. Water and mixtures of water and glycerol as well as aqueous solutions of polyvinylpyrrolidone (PVP) are sprayed. The observed operating parameters cover pressures up to 0.5 MPa and ALR in the range of 0.1 to 10.

In the first experiments with low viscous liquids like water the drop size distribution shows quite similar results as the conventional nozzle, shown in Figure 2. Benefits of the spray characteristics are visible at high ARL as the pulsation of the spray is significantly less for the capillary nozzle in comparison to the conventional nozzle. Further advantages of the capillary nozzle are evident for higher liquid viscosities.

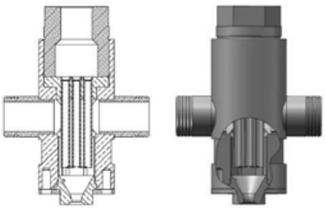

Figure 1 modified pneumatic nozzle

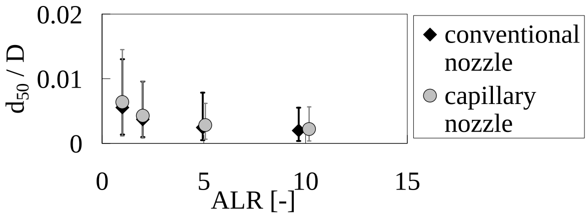

Figure 2 drop size distribution, liquid: water, gas: air at 0.5 MPa

[1] Sutherland, J. J., Sojka, P. E., Plesniak, M. W., *International journal of multiphase flow*, 23 (5): 865–884, (1997)
[2] Lörcher, M., Schmidt, F., Mewes, D., *Atomization and Sprays*, 15:145-168, (2005).
[3] Luong, J. T. K., Sojka, P. E., *Atomization and Sprays*, 9 (1): 87-109, (1999).
[4] J. Schröder, M. Schlender, P. E. Sojka, V. Gaukel, H. P. Schuchmann, *ILASS-Europe*, Brno, CZ, 2010.
[5] S. Groom, PhD Thesis, TU Dortmund, 2006.

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** German patent application DE 102010 012 555.5-51